An Additional Contribution to the Biology of the Aholehole, *Kuhlia sandvicensis* (Steindachner)[1]

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RELATIVELY LITTLE is known of the biology of the inshore fish fauna of the Hawaiian Islands, although there have been numerous publications on various aspects of the subject (Pietschmann, 1938; Gosline and Brock, 1960; Helfrich, 1959; Hiatt, 1947*a*, 1947*b*, 1951; Randall, 1955, 1958, 1961; Strasburg, 1961, 1962; Strasburg and Hiatt, 1957; Salmon, 1967; Tester, 1951, 1955; Tester and Takata, 1953; Tester and Trefz, 1954). The purpose of this paper is to present further information concerning the growth and age of a common inshore species, the aholehole (*Kuhlia sandvicensis*).

MATERIALS AND METHODS

These data were obtained from a population of individually marked fish which were kept for over a year in a large marine pond at the Hawaii Marine Laboratory on Coconut Island, Kaneohe Bay, Oahu. All fish were initially placed into one of five arbitrarily designated size classes. The fish in size class I ranged from 80 to 100 mm fork length, class II from 101 to 120 mm, class III from 121 to 140 mm, class IV from 141 to 160 mm, and class V from 161 to 180 mm.

At approximately monthly intervals, the pond was seined and the recaptured fish anesthetized with Quinaldine (2-methyl-quinoline). Length and weight measurements were then made and scale samples taken in conjunction with a concurrent study of scale growth. The fish were then allowed to recover from the anesthetic in holding tanks before being released into the pond. All measurements were made to the nearest 0.1 mm and 0.1 gram.

The pond in which this introduced population of fish was kept was rectangular, measuring 60 by 100 feet. The depth varied from 2½ to 4½ feet, depending on tidal conditions and the particular locale within the pond. The sides were constructed of stacks of large dead coral heads, and the bottom was composed mainly of sand, silt, and pieces of dead coral. Two large screened gates were provided at opposite ends of the pond to allow natural water circulation and tidal changes.

That the conditions under which the fish were maintained approximated the natural environment is evidenced by earlier observations of a small resident population of the same species in a similar, adjacent pond (Tester and Takata, 1953).

Although natural foods such as annelids and crustaceans were frequently observed in the pond, the diet of the introduced population of aholehole was supplemented by the addition of bread, commercial fish meal, and minced fish flesh.

RESULTS

As expected, the data indicate faster growth rates for smaller fish (Table 1). Fish in size class I grew at rates of 0.120 mm and 0.073 gram per day. Fish in size classes II, III, IV grew at rates of 0.110, 0.070, 0.040 mm per day, respectively. The daily increases in weight for the same groups were 0.092, 0.071, 0.040 gram per day. Size class V, which consisted of very large fish, failed to show significant increases in length for the duration of the study. However, slight increases in weight were detected (0.004 gram per day).

Seasonal growth differences were not observed in all size classes. Sex differences in growth rates could not be studied for two reasons. First, difficulty was encountered in determining sex on the basis of external morphology. Second, throughout the entire study there was a

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TABLE 1
THE GROWTH OF THE AHOLEHOLE (*Kuhlia sandvicensis*)

NO. FISH	SIZE CLASS	FORK LENGTH (mm)	GROWTH RATE (mm/day)	GROWTH RATE (g/day)
10	I	80.0–100.0	0.120	0.073
33	II	101.0–120.0	0.110	0.092
49	III	121.0–140.0	0.070	0.071
20	IV	141.0–160.0	0.040	0.040
4	V	161.0–180.0	0.000	0.004

small but steady rate of escape from the enclosure which necessitated a constant replenishment of the population.

By extracting an equal number of points directly off growth curves for each of the five size classes, "Walford curves" estimating the maximum size of this species were constructed (Walford, 1946). The calculated theoretical maximum length and weight values of 198.0 mm and 109.2 grams are reasonable approximations of field observations made by the writer during this project. Recent investigators, however, have observed aholehole of greater size than these estimates (Niimi, 1967, personal communication).

Because it is difficult to determine the age of fish which live in uniformly warm waters (Lagler, Bardach, and Miller, 1962), age estimates of aholehole were made on the basis of growth rates and relative sizes. From a composite growth curve formed by the combined curves of the five size classes, it was estimated that this species requires about 1,330 days (3.6 years) to grow from 87.5 to 170.5 mm fork length. Data obtained by earlier investigators (Tester and Takata, 1953) were used for the assignment of ages to smaller fish, since this study did not include individuals less than 87.0 mm fork length. Thus it was possible to determine length-age relationships covering almost the entire size range of this species (Table 2, Fig. 1).

TABLE 2
AGE ESTIMATES OF THE AHOLEHOLE
(*Kuhlia sandvicensis*)

ESTIMATED AGE (years)	FORK LENGTH (mm)
1 or less	to 102.7*
2	102.8–142.2
3	142.3–158.8
4	158.9–170.5
5	170.6+

* Based on data from Tester and Takata (1953).

The length-weight relationship of the aholehole was determined from measurements of fish recaptured throughout the year in the pond. Clugston (1964), working with two subspecies of largemouth bass, used a similar format. An "individual b" value (Ricker, 1958) of 2.75 was calculated for the fish used in this study (Log Wt. $= -1.51 + 2.75$ Log Lt.). This is shown in Figure 2. Similar values were obtained for two groups captured during the same period from the original habitat of the introduced population.

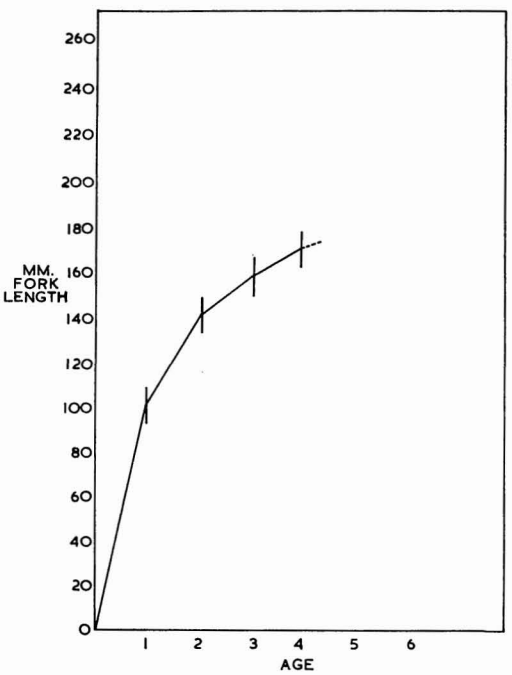

FIG. 1. The age-length relationship of the Aholehole.

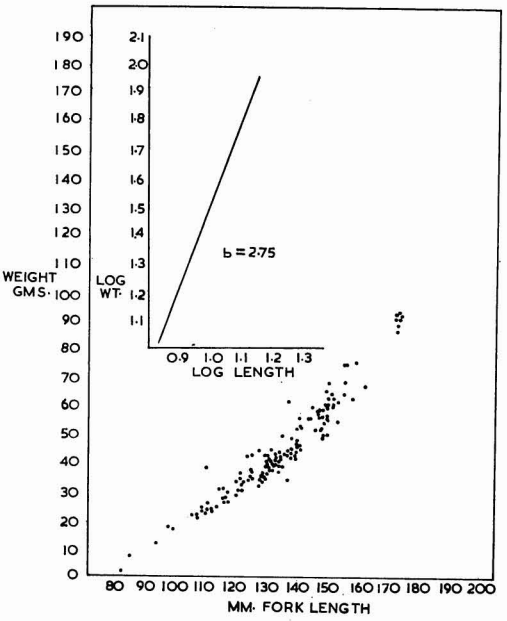

FIG. 2. The length-weight relationship of the Aholehole

SUMMARY

1. The growth rates of the aholehole (*Kuhlia sandvicensis*) introduced into a marine pond were measured. In general, smaller fish displayed higher growth rates than larger fish.

2. Age estimates were made on the basis of growth rates and relative sizes because of the difficulty in determining age of fish from uniformly warm waters.

3. Calculations of the theoretical maximum length and weight of the aholehole were made. These values were estimated at 198.0 mm fork length and 109.2 grams in weight.

4. The length-weight relationship of the aholehole was determined with a calculated "individual b" value of 2.75.

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